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Comparing Acquisition of Exchange-Based and Signed Mands With Children With Autism

Kathryn E. Barlow, Louisiana State University
Jeffrey H. Tiger, University of Wisconsin-Milwaukee
Sarah K. Slocum, University of Florida
Sarah J. Miller, Louisiana State University

Therapists and educators frequently teach alternative-communication systems, such as picture exchanges or manual signs, to individuals with developmental disabilities who present with expressive language deficits. Michael (1985) recommended a taxonomy for alternative communication systems that differentiated between selection-based systems in which each response is topographically identical (e.g., card selection and exchange systems) and topography-based systems in which each response is topographically distinct (e.g., signed language). We compared the efficiency of training picture exchanges and signs with 3 participants who presented with severe language deficits; all participants acquired the picture-exchange responses more readily.

Key words: autism, mands, picture exchanges, selection-based communication, signs, topography-based communication, verbal behavior

Therapists frequently use direct-instruction techniques to teach verbal behavior to individuals with intellectual and developmental disabilities (IDD). This instruction involves arranging appropriate antecedents and reinforcing consequences to develop mands, tacts, intraverbals, and echoics (Skinner, 1957). Ideally, this instruction involves teaching these verbal operants as vocal responses; however, it is common to teach alternative-communication systems such as sign language or exchange-based communication systems (e.g., the Picture Exchange Communication System, or PECS; Bondy & Frost, 1994) to individuals with deficient vocal-verbal repertoires.

Michael (1985) suggested that it may prove useful to classify these alternative-communication systems as either selection-based or topography-based communication. According to this taxonomy, selection-based (SB) systems are those in which a speaker is presented with multiple stimuli and engages in verbal behavior by selecting a particular stimulus. In other words, each response is topographically identical (e.g., a point) and each response is differentiated by the selected stimulus (e.g., pointing to a card that says ''candy'' versus ''play''). Topography-based (TB) systems are those in which each response is topographically distinct in terms of sound, duration, force, and direction. Topography-based systems most commonly involve either vocal language or sign language.

Selection-based and topography-based systems are common in early language instruction with individuals with IDD and vocal-language deficits, but Sundberg and Sundberg (1990) suggested that SB systems may be preferred because: (a) SB systems require less time and effort to teach caregivers to respond as listeners (i.e., caregivers typically have a learning history to respond to a word or picture as opposed to a signed gesture), and (b) developing sign repertoires can involve shaping the speaker's motor skills, which may not be fully developed. It may also be difficult to discriminate the occurrence of a signed response from an individual who engages in hand-related stereotypies. Despite the apparent relative ease of SB systems, Michael (1985) suggested that individuals with IDD may acquire TB systems more readily. Specifically, he noted

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Correspondence concerning this article may be addressed to: Jeffrey H. Tiger, Department of Psychology, University of Wisconsin-Milwaukee, 2441 E. Hartford Ave., 219 Garland Hall, Milwaukee, WI 53201. (e-mail: tiger@uwm.edu).

that SB systems require a developed scanning and selection repertoire as well as the ability to make conditional discriminations, which are frequently absent among individuals with IDD. These prerequisites are not required for effective use of TB systems in which there is point-to-point correspondence between each response and its reinforcer.

In addition to these challenges, Sundberg and Sundberg (1990) offered a few practical limitations of SB systems. First, SB systems require the use of equipment (e.g., a microswitch or a card book), which is not physically available at all times, whereas TB systems require no additional equipment. Second, some words (e.g., verbs) are difficult to depict through symbols or pictures, but American Sign Language (ASL) provides a standard gesture for nearly all English-language words. Third, the listener must remain close to the speaker in order to see and respond to SB systems. By contrast, signing and vocalizing can be performed and recognized from a distance.

The proposed limitations of teaching verbal behavior through SB training were speculations from Michael's (1985) paper, but some empirical evaluations have provided support for his assertions. Sundberg and Sundberg (1990) compared the acquisition rate of tacts, responses occasioned by a nonverbal discriminative stimulus that results in social reinforcement (Skinner, 1957), and intraverbals, responses occasioned by a verbal discriminative stimulus, which do not share a point-to-point correspondence with the occasioning stimulus and result in social reinforcement (Skinner), for nonsense objects and symbols using SB and TB instruction. Results showed that TB instruction required fewer trials and resulted in more correct responses than SB instruction. The authors also found that TB instruction led to the emergence of more untrained listener responding. Wraikat, Sundberg, and Michael (1991) conducted a replication of Sundberg and Sundberg with similar outcomes.

More recently, researchers have begun to compare SB and TB systems in the development of mands. A mand is a verbal operant in which the response is evoked by a relevant establishing operation and reinforced by a characteristic consequence (Michael, 1988; Skinner, 1957). Michael argued that mand training is particularly important for people with IDD. First, although typically functioning adults and children can be taught tacts and will then also engage in these responses as mands, these response classes will frequently maintain their functional independence among individuals with IDD (Finn, Miguel, & Ahearn, 2012; Lamarre & Holland, 1985; Wallace, Iwata, & Hanley, 2006), therefore requiring the direct training of mands. Second, because mands are directly reinforced by their consequences, learners may be more likely to participate in other educational or socially beneficial activities that may involve manding (i.e., early mand training may facilitate later participation and compliance). Manding is also beneficial as it can reduce problem behavior by replacing inappropriate ''requesting'' topographies (e.g., aggression) with more appropriate ones, such as signing (Carr & Durand, 1985).

Tincani (2004) compared SB (in this case PECS) and TB systems (in this case American Sign Language) in the development of mands with two children diagnosed with autism. The authors alternated SB- and TB-instruction conditions within a multielement design and found that one participant more readily acquired sign language (TB) and one participant more readily acquired the picture-exchange system (SB). This study was notable but suffered from a few methodological limitations that raise concerns regarding the results. First, different stimuli were assigned to the SB and TB training conditions. Thus, it is possible that differential preference for items (or differential response effort) may have influenced the results. Second, the authors used different prompting and prompt-fading strategies across conditions. In the SB-instruction condition, the authors implemented a full physical prompt and gradually faded the intensity of that prompt, whereas in the TB-instruction condition, the authors implemented a progressive time-delay procedure. It is unclear how the differences in prompting and prompt fading may have influenced their results. Third, the authors presented picture cards in isolation (i.e., without comparison stimuli) during the SB-instruction condition. This may have favored results toward the SB system as scanning and making conditional discriminations were the likely challenges for learners using SB systems (Michael, 1985).

Ziomek and Rehfeldt (2008) also compared the acquisition of mands via picture exchanges and manual signs with four adults with developmental disabilities. Similar to the study by Tincani (2004), these authors (a) assigned high-preference materials either to a picture exchange or sign condition and (b) used the procedures described in the PECS training manual to teach picture exchanges but developed a different prompting procedures for signed mands. In each case, in which training was completed, picture-exchange responses were acquired more rapidly than sign language; in fact, none of these participants met mastery for signed language prior to a termination criterion. However, the prompting strategies again differed across conditions.

Chambers and Rehfeldt (2003) compared the acquisition of mands via PECS and signed language with four adults with intellectual disabilities. The authors simultaneously taught PECS and signed mands for the same four items (M&M, puzzle, string beads, and carrots) for each participant using identical graduated prompting strategies; however, the authors presented picture cards singly during their PECS condition (i.e., learners were not required to make conditional discriminations). This limitation is noteworthy as each of their participants acquired PECS responses more rapidly than signed responses (i.e., scanning an array is presumably a challenge associated with SB systems).

Finally, Gregory, DeLeon, and Richman (2009) conducted the most rigorous comparison of SB and TB systems to date. The authors simultaneously taught an exchange-based system using pictures and a manual sign using identical prompting procedures (a 20-s delayed model prompt followed by a 20-s delayed physical prompt) for identical reinforcers with six children diagnosed with autism and intellectual disability. Each of the six children more rapidly acquired the SB mand. Three of the children never engaged in a TB response during their evaluation. It is worth noting too that during their exchange-based training, the authors initially presented only a single card but gradually increased the comparison array to four cards.

The current study was designed to further compare the efficacy and efficiency of SB and TB alternative-communication training strategies using procedures similar to Gregory et al. (2009). In order to provide the most equal comparison of these communication strategies (a) we simultaneously taught SB and TB mands for the same items to eliminate differential reinforcer preference and sign difficulty across conditions, (b) we used the same prompting and prompt-fading procedures across conditions, and (c) we presented the target picture cards in a three-card array to account for the challenges associated with acquiring a SB repertoire from the onset of SB instruction.

METHOD

Participants and Setting

Participants were three children diagnosed with autism spectrum disorders by physicians not associated with this study. Joey was a 2-year-old boy diagnosed with autism by his pediatrician who was receiving home-based early intensive behavioral intervention (EIBI). He presented with no intelligible vocal-verbal behavior and had limited exposure to sign language or picture-exchange systems. Prior to the onset of the study, Joey did not engage in matching of simple shapes or colors (data teaching Joey to match are presented in Slocum, Miller, & Tiger, 2012), nor did he engage in much imitative behavior (we assessed and provided instruction in motor imitation concomitant with his participation in this study using procedures similar to Baer, Peterson, & Sherman, 1967). His predominant mand form consisted of leading an adult to a desired item and grunting. We conducted Joey's sessions (M = 9 daily; range 2 to 14) within the context of his EIBI services, which were conducted 3 hours per day Monday through Friday.

Wyatt was a 6-year-old boy diagnosed with autism by his pediatrician and was referred by his teachers for lacking the ability to communicate his needs. He produced no intelligible vocal-verbal behavior, had little exposure to sign language or PECS, and demonstrated few motor-imitation abilities (assessed again using procedures similar to Baer et al., 1967). We did not formally assess his matching skills. Wyatt rarely requested items, but when he did, his predominant

mand form consisted of leading a person to his desired object. We conducted a mean of four sessions per day (range, 1 to 8) in an empty room at Wyatt's school.

Sam was a 5-year-old boy diagnosed with autism by his pediatrician and referred by his parents for lacking the ability to request preferred items. He had no comprehensible vocal-verbal behavior, had little exposure to sign language or PECS, but did demonstrate an imitative motor repertoire; we did not formally assess Sam's matching skills. Sam used the ASL sign for ''bathroom'' inconsistently, but his predominant mand form was pulling a person's hand toward a desired item. We conducted sessions in Sam's home 1 hour per day, 4 days per week (M = 6 sessions per day, range 3 to 10).

Materials, Measurement, and Interobserver Agreement

For SB trials, we developed communication cards by taking digital photographs of target and nontarget items, printing color pictures (for Sam and Wyatt, these measured approximately 5.1 cm by 5.1 cm, and for Joey 10.2 cm by 15.2 cm), and laminating each picture. During SB-instruction sessions, we defined a correct response as picking up the target picture card and handing it to the therapist. For TB trials we selected signs based upon ASL with some modifications for the motor capabilities of our participants. For Joey, we defined the signs for ''iPod'' as presenting the index and middle fingers in a ''v'' formation with the other fingers in a fist, for ''milk'' as the formation of one closed fist with knuckles facing toward the torso, and for ''chip'' as the presentation of one hand, palm facing up and the other hand in a ''c'' formation with at least 2.5 cm between the thumb and other four fingers; the hand in the ''c'' formation had to move across the palm of the bottom hand at least one time. For Wyatt, we selected the sign for ''candy'' as a mand for a Skittle® and defined this response as contact of the index finger to the cheek with the remaining fingers in a fist formation; the index finger was required to make at least one downward motion on the cheek. For Sam, we selected the sign for movie as a mand for a Barney video and defined this response as the presentation of one outward-facing hand above the other hand with the bottom hand palm-side down; both hands had to be above the plane of the waist with no more than 15 cm between each hand. For Sam we also selected the sign for ''sweet'' as a mand for Mike and Ike candy and defined the response as the index and middle fingers placed together with the remaining fingers in a fist formation; the index and middle fingers had to make at least one downward motion across the chin.

Trained data collectors manually recorded responses on a trial-by-trial basis and specified responses as occurring independently or following a vocal, model, or physical prompt (collectively scored as a prompted response). To obtain interobserver agreement, two observers collected data simultaneously but independently during 42% of sessions for Joey, 57% of sessions for Wyatt, and 42% of sessions for Sam. We compared observers' records during these sessions on a trial-by-trial basis in which we scored each trial either in agreement (defined as the exact same code in both records) or in disagreement (defined as any disagreement between records). For each of these sessions, we divided the sum of the number of trials scored in agreement by the total number of trials and converted this quotient to a percentage. The mean agreement for independent responses was 98.6% (range, 30% to 100%) across all conditions for Joey, 97.9% (range, 80% to 100%) across all conditions for Wyatt, and 100% across all conditions for Sam. The one score of 30% for Joey appeared to result from a data collector missing the first trial; the two data collectors were then out-of-sync for the remainder of the session.

Procedures

Each participant experienced a preference assessment to identify putative reinforcers for mand instruction, a baseline condition to ensure that participants did not exhibit the target SB or TB responses, and a mand-instruction comparison phase. Mand-instruction comparison phases involved teaching an SB and a TB mand for the same reinforcer in alternating sessions conforming to an adapted alternating-treatments design. This comparison continued until one response (SB or

TB) met our mastery criterion of three consecutive sessions with 80% or more of trials with independent responding. For some participants, we initiated this mand-instruction comparison sequentially across multiple items conforming to a multiple-probe design.

Preference assessment. We conducted the Reinforcer Assessment for Individuals with Severe Disabilities interview (RAISD; Fisher, Piazza, Bowman, & Amari, 1996) with participants' parents to nominate potential highly preferred food and leisure items, which we then included in a paired-item preference assessment using the procedures described by Fisher, Piazza, Bowman, Hagopian, Owens, and Slevin (1992). For Joey, we identified chips, milk, and access to an iPod (the iPod was uploaded with a variety of children's shows and applications that he was able to operate independently). For Wyatt, we identified Skittles as preferred. For Sam, we identified a Barney video and Mike and Ike candy as preferred.

Baseline. Prior to the mand-training comparison, we conducted a minimum of three 10-trial baseline sessions to occasion SB and TB responding. For Joey and Wyatt, we randomly determined which session would be conducted first in each comparison and then alternated SB and TB sessions throughout the remainder of the comparison. For Sam, we alternated sessions randomly throughout his comparisons. We placed a sheet of paper on the table in front of the participant during all SB sessions and an orange sheet during all TB sessions to facilitate discrimination between conditions. During SB-baseline sessions, we presented the target card and two other comparison cards in a horizontal array on a table in front of the participant. We alternated the position order of these cards randomly across trials. The comparison cards consisted of images of items that would not be targeted for mand-instruction during the course of the study. We always presented leisure items in an array with other leisure items and edible items in an array with other edible items. To initiate a trial, we held the putative reinforcer in front of the participant's visual field from a distance of approximately 1 m to signal its availability. We then waited 5 s for an independent response. If the participant did not respond within 5 s, we removed the target item (held it under the table) for 2 s and then re-presented the item in front of the participant to initiate the next trial. If the participant responded correctly, we did not provide access to the reinforcer; rather, we removed the item for 2 s prior to initiating the next trial. Sessions during the TB baseline were similar except that we removed the picture card array and instead targeted a signed response.

Selection-based (SB) mand instruction. The physical arrangement of SB-instruction sessions was identical to sessions during the baseline condition. Before each 10-trial session, the therapist briefly placed the target item in front of the participant to signal its availability. Each trial began with a 5-s delay during which the participant could emit an independent mand that would result in 30-s access to the reinforcing stimulus in the case of a leisure item or one piece of food in the case of an edible item. If the participant did not respond during the 5-s delay, or responded incorrectly, then the therapist initiated a graduated-prompting hierarchy to teach the target mand. For Sam, we used a three-step prompting hierarchy in which we sequentially provided a vocal prompt (''If you want something, ask for it''), a model prompt (i.e., the therapist repeated the vocal prompt and demonstrated the target response), and then physical prompt with a 5-s delay interval between prompts. For Joey and Wyatt we implemented a two-step hierarchy in which we provided a vocal and then a physical prompt. We omitted the model prompt for Joey and Wyatt as they did not demonstrate a motor imitation repertoire at the time of this study.

Topography-based (TB) mand instruction. The physical arrangement of TB-instruction sessions were the same as TB-baseline sessions, and all procedures were identical to those of SB-instruction sessions except that (a) the picture cards were not present during sessions, (b) the target response was a motoric gesture, and (c) the physical prompting provided was to complete the motoric sign in lieu of selecting a card. We initiated each trial by presenting the putative reinforcer approximately 1 m in the line of sight of the participant and allowed a 5-s delay during which a target sign would produce access to the reinforcer (30-s for leisure items or 1 edible

item). If the participant did not respond during the delay interval, the therapist then initiated a graduated prompting hierarchy. That is, if the participant did not respond within the 5-s delay, the therapist provided a vocal prompt (''If you want something, ask for it''), waited an additional 5 s, provided a model of the target response (Sam only), and then following an additional 5-s delay, physically guided the participant to complete the motor response.

RESULTS

We conducted baseline sessions to assess Joey's pre-instruction level of responding for an iPod, chips, and milk; he engaged in near-zero levels of SB and TB responses (Figure 1). We initiated the mand-instruction comparison with the iPod as a reinforcer (top panel). Joey met mastery of the SB mand for the iPod after 21 sessions. He did not engage in a single instance of the TB response during this time period. We conducted an additional 6 TB sessions (27 total sessions or 270 trials), during which he did not make a single independent response. At this point we terminated instruction of the TB mand and conducted an additional baseline session of SB and TB responding for chips (middle panel); Joey engaged in independent SB responses during 6.7% of trials across the SB baseline and did not engage in the TB mand. We initiated instruction for both mands and Joey reached mastery criterion for the SB mand after 16 instructional sessions. Again, he did not engage in an independent TB mand during this time or after an additional 6 sessions of exclusive TB instruction. We therefore terminated instruction in the TB condition and conducted additional baseline sessions of Joey's responding for milk (bottom panel). Joey engaged in SB mands during 5.6% of baseline sessions and did not engage in any TB mands. Joey reached mastery criterion for SB mands after 7 sessions but never engaged in an independent TB mand after 13 sessions.

We conducted baseline sessions to assess Sam's pre-instruction level of responding for movie and candy during which he engaged in zero levels of the SB or TB responses (Figure 2). We initiated the mand-instruction comparison with movie serving as the reinforcer (top panel). Sam reached mastery criterion for the SB response after 3 sessions but never engaged in independent TB responses after 9 sessions; we then terminated TB instruction. We conducted an additional baseline probe for SB and TB responding for candy (bottom panel); Sam engaged in independent SB responses during 5% of sessions and never engaged in independent TB responses. Sam met mastery criteria for the SB mand after 9 sessions but never engaged in independent TB mands after 13 sessions.

We conducted baseline sessions to assess Wyatt's pre-instruction level of responding for candy during which he engaged in zero levels of SB or TB responses (Figure 3). We then began the mand-instruction comparison with candy serving as the reinforcer. Wyatt met mastery criterion for the SB mand after 11 sessions. He did engage in independent TB responses for 1.6% of sessions but never met mastery criteria for the TB mand after 17 sessions. We were not able to train subsequent items for Wyatt due to his unexpected departure from school (we collected baselines for additional targets that are not presented).

Overall, each of the 3 participants, with a total of six mand-instruction comparisons, reached the mastery criterion for their target item(s) given SB instruction. However, none of the participants reached mastery criterion for their target item(s) given TB instruction. Across all participants, the mean number of sessions to reach mastery criterion per item given SB instruction was 15 training sessions (150 trials).

DISCUSSION

In the current study, we compared the relative efficacy of mand instruction targeting SB (picture exchange responses) and TB (signed) responses with three young boys diagnosed with autism who did not demonstrate any intelligible vocal-verbal behavior. Each participant acquired the SB-communication response for each of the targeted items, but none acquired the TB-communication response for any of the targeted items. These findings extend the literature comparing SB- and TB-communication systems and raise some additional interesting questions.

Early studies comparing SB- and TB-communication targeted tacts and intraver-

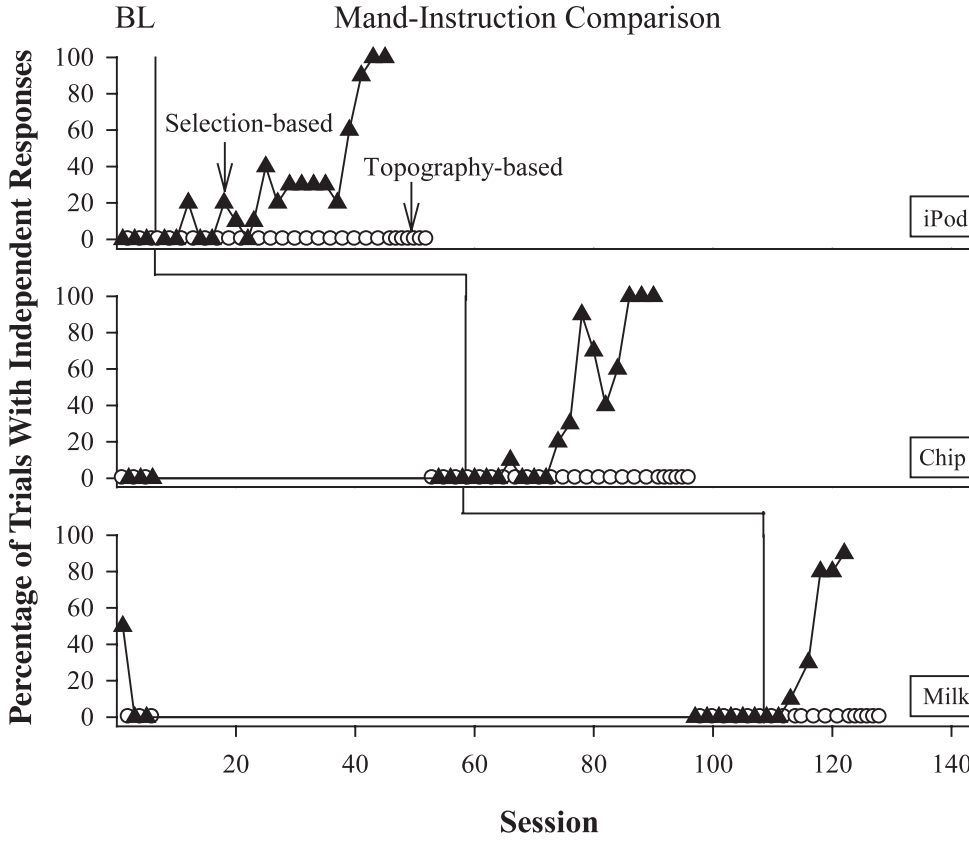

Figure 1. The percentage of trials Joey engaged in independent selection-based (SB) and topography-based (TB) mands across the iPod, Chip, and Milk.

bals (Sundberg & Sundberg, 1990; Wraikat et al., 1991) and generally showed superior acquisition and generalization of responding with TB systems. More recent research has focused on mand development; however, many of these studies contained methodological features that make it difficult to draw firm conclusions (Chambers & Rehfeldt, 2003; Gregory et al., 2009; Tincani, 2004). Despite a few methodological concerns, the results of each of these studies and our current study have been similar; manding was acquired more rapidly given SB systems. From these outcomes, one may be tempted to draw the conclusion that TB systems are superior in developing tacts and intraverbals and SB systems are more effective in developing mand repertoires. However, we believe that such a conclusion would be premature and would lead to exceptionally complicated decision-making problems for therapists who are attempting to teach complete language repertoires (i.e., developing different systems for different verbal operants would likely be problematic). We would suggest that future research is necessary in which individuals are taught multiple verbal operants (i.e., tacts, mands, and intraverbals) using SB and TB systems to determine if there are indeed within-subject differences in sensitivity across verbal operants or if the differences observed across studies can be better attributed to across-subject differences (i.e., some individuals are more likely to acquire verbal operants given SB or TB instruction rather than some verbal operants are better trained with one system versus the other). However, it is not clear what would predict those across-subject differences.

Several authors have suggested a number of prerequisite skills that would likely be

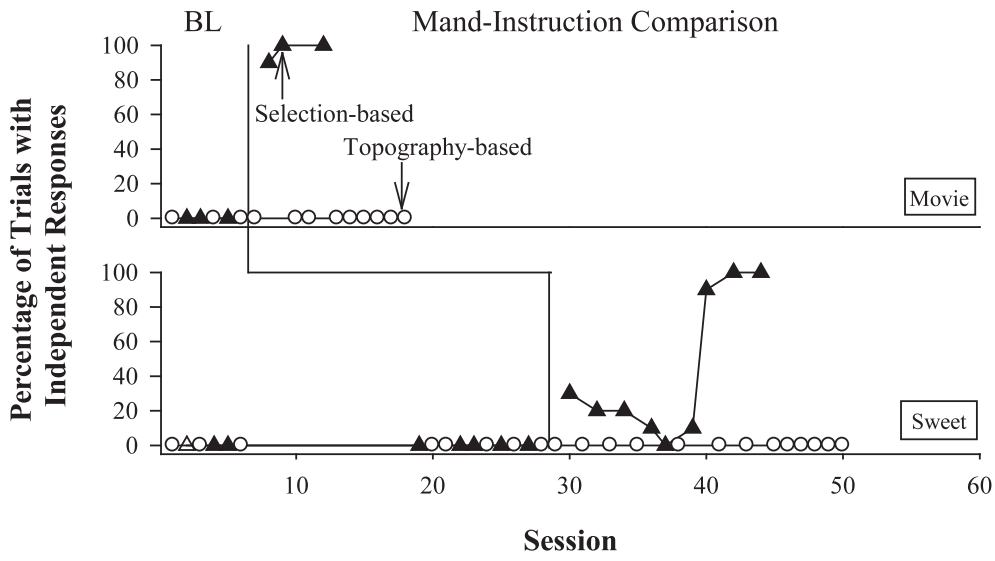

Figure 2. The percentage of trials Sam engaged in independent selection-based (SB) and topography-based (TB) mands for the Barney™ movie and Mike and Ike® candy.

necessary for, or at least facilitate, acquisition of one communicative system relative to the other. Michael (1985) suggested individuals would require the ability to scan arrays, make conditional discriminations, and make selection responses to acquire SB systems. Gregory et al. (2009) suggested that matching may be an important prerequisite for SB systems and motor imitation may be an important prerequisite for TB systems and then sought to evaluate that hypothesis by assessing these repertoires prior to teaching SB and TB systems. Unfortunately, neither repertoire was predictive of future acquisition; children mastered SB mands without a matching repertoire and, in general, learners with both repertoires tended to acquire both responses more quickly. We did not formally assess these prerequisite repertoires in our current study, but informally found these repertoires to be deficient in each participant. Nonetheless, each of our participants acquired a number of SB mands.

It is notable and surprising that none of our participants developed TB (signed) mands, despite the success of similar procedures available in the literature. It is clear that this lack of acquisition was not due to the absence of an effective reinforcer, as the same reinforcer was used to develop SB mands in each case. It is possible that our participants failed to acquire these responses due to a lack of an imitative repertoire. However, we would also note Thompson, McKerchar, and Dancho (2004) and Thompson, Cotnoir-Bichelman, McKerchar, Tate, and Dancho (2007) taught signed mands to young infants, who generally have yet to develop sophisticated motor imitation, using procedures similar to ours.

It is possible our participants did not develop signed responses because we selected motor responses that were overly difficult. We specifically selected and modified signs that appeared to be appropriate given our participants' motor-skill level, but this remains a possibility. It is also possible that we simply did not provide enough time for signs to develop. We felt that given the rapidity with which SB responding developed that it was more appropriate to initiate the next comparison condition than to conduct TB training ad nauseam. Finally, it is possible that the alternation between SB and TB sessions within an alternating-treatments design hindered the development of TB responding. For instance, the presence of the stimulus materials (the picture cards) may have obtained stimulus control over *all* manding and the absence of these materials

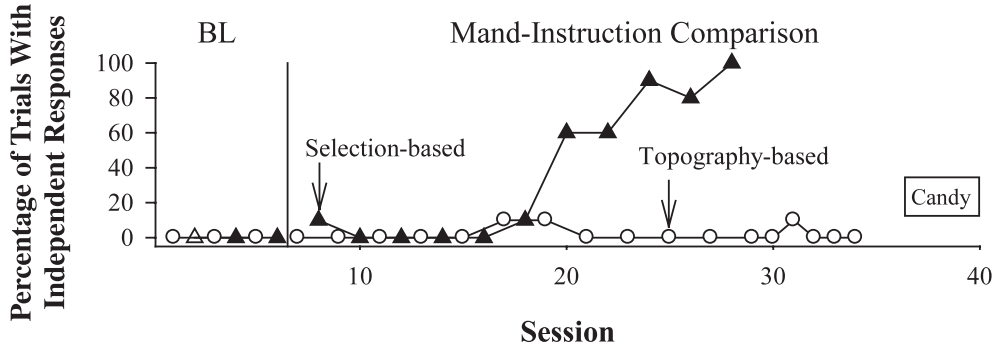

Figure 3. The percentage of trials Wyatt engaged in independent selection-based (SB) and topography-based (TB) mands for Skittles®.

suppressed responding or that participants developed a preference for SB responding and simply ''waited'' for these sessions to engage in manding.

From this discussion, it should be clear that the reasons that our participants did not acquire sign are not abundantly clear; although we note similar findings were reported in Gregory et al. (2009) and Ziomek and Rehfeldt (2008). There is no definitive pre-instruction idiographic assessment to determine which communication system would be most efficacious. In the absence of a clear assessment to predict the efficacy of SB and TB instruction, the current procedures may prove useful. That is, by exposing participants to each treatment procedure within an adapted alternating-treatments design, one may be able to rapidly determine differential sensitivity to one form of language instruction. We used the outcomes of this comparison to prescribe continued instruction using that communicative system to develop additional verbal behavior skills for these participants outside of this study. However, the utility and sensitivity of this comparison as an assessment would need to be validated by also accurately predicting learners who would more rapidly acquire signed language (presuming there are some). We also caution that the alternating-treatments design can introduce multiple-treatment interference. It is possible that the efficacy of one instructional procedure may promote acquisition under the other condition (i.e., if exchange training resulted in higher levels of sign) or if the acquisition of one response competed with the acquisition of the other response (e.g., if sign has been acquired and occurred under the picture exchange condition to the exclusion of card exchanges).

Future researchers may consider evaluations of participants' preferences for these communication systems as well. Based upon the effort of each response, the need to carry equipment for SB systems, the consistency with which these materials are available, and the consistency with which SB and TB systems are reinforced in the natural environment, it is likely that individuals would develop a preference for one communication system over the other. For instance, Richman, Wacker, and Winborn (2001) assessed one child's preference for a picture-exchange system relative to signs within the context of treatment for aggression maintained by social-positive reinforcement. Therapists in this study taught the participant both a signed response and PECS response to gain access to a preferred item. After both responses were acquired, the participant could have gained access to tangible items via a card exchange, a sign, or aggression; the participant engaged nearly exclusively in signs. Honoring individual children's preferences may both improve the efficacy of interventions and allow individuals with intellectual disabilities a greater degree of autonomy and self-determination in the treatment-decision process (Hanley, 2010).

To a large extent, the utility of SB- and TB-communication systems will be measured by the extent to which they result in generalized manding across settings and communicative partners and in the development of complete

language repertoires including tacts and intraverbals. We did not evaluate the generality of manding responses in the current study, nor the development of more complex mands (e.g., those occurring within an autoclitic frame, such as ''I want''; these are common goals in some SB communication systems). Chambers and Rehfeldt (2003) examined the generality of their mand responses to conditions in which the reinforcing item was absent (i.e., toward an evaluation of spontaneous manding) and in another setting. Both of these evaluations yielded positive results, but future research will be needed to determine the optimal training conditions to generate generalized manding.

Although we consider the current study to be a comparison of SB- and TB-communication systems, we only included one SB system (picture exchange) and one TB system (signs). Picture exchanges are the most prevalent SB system, but it is not uncommon for individuals to use switch-press devices as well, and there is an ever-growing supply of electronic SB systems (i.e., those that operate on smart phones and tablet computers). It will likely prove difficult to make generalizations regarding SB systems as the complexity of response chains necessary to operate these different systems varies considerably. Thus, future research utilizing selection or exchange-based systems should also include these emerging technologies.

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